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Fitness for Fire and Rescue. Standards, Protocols and Policy.



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Chapter 1

1.1 Introduction

The purpose of this document is to outline safe, accurate, reliable and cost effective methods of assessing Firefighter fitness levels and to identify the most suitable tests to use. It is recognised that there is a wide range of knowledge and skills within each Fire & Rescue Service, which will influence the type of assessment method employed. This document provides a toolkit of tests with supporting documentation, which will offer solutions for all Fitness Advisers, Occupational Health Advisers and Human Resource Managers within Fire and Rescue Services. Furthermore, based on the currently available scientific research, recommendations are presented for a national standard for aerobic fitness for safe, effective firefighting.

Chapter 2

2.1 Background

In early 1999, the Chief Inspector of Fire Services initiated a review as a result of growing concerns about the impact that sickness absence and ill-health retirements were having on the efficiency and effectiveness of the Fire Service. The report recommended that “Routine 6-monthly fitness checks should be compulsory for all operational personnel (wholetime and retained), and offered on a voluntary basis to all other staff” (Home Office, *Fit for Duty? Seeking a Healthier Workforce*, 2000). The authors saw three potential benefits of regular fitness testing: assurance that staff were fit to undertake their role, improved health of the workforce, and improved attendance at work. More recently, a Fire and Rescue Service Circular on the Building Disaster Assessment Group’s key research findings also reported: “ Fire and Rescue Services are reminded of the importance of ensuring that operational staff maintain fitness levels appropriate to their role. Regular fitness testing is important to ensure that staff maintain the required level of fitness to fulfill their role safely and effectively” (ODPM, 2004a). However, until now no guidance has been offered to identify how this should be carried out.

It is well established that a Firefighter’s work can sometimes be physically demanding and require sustained effort for long periods, often in arduous conditions. Cardiorespiratory fitness, muscular strength and endurance, and body composition are major determinants of Firefighter performance (ODPM – Operational Physiological Capabilities of Firefighters: Literature Review and Research Recommendations, 2004). Consequently, an appropriate level of physical fitness is a key element in ensuring Firefighter effectiveness and in protecting their health and safety. This becomes especially relevant when the physical demands of the job appear to be insufficient to enhance or maintain role-specific fitness levels (ODPM, 2004). Furthermore, from a health perspective, low levels of physical activity and fitness are now well recognised as risk factors for cardiovascular and other diseases. Increasing activity and fitness levels will help reduce the risk of these occurring as well as improving other aspects of health and well being, such as stress, depression and weight control (Fire & Rescue Service Manual, Volume 4, Fire Service Training - Foundation Training and Development, 2004).

Chapter 3

3.1 Health and safety

Whilst the complications associated with exercise testing appear to be relatively low, the ability to maintain a high degree of safety depends on knowing when not to perform an exercise test (ACSM, 2006). Therefore, it is important to carry out an initial screening of participants relative to risk factors and / or symptoms for various chronic diseases (cardiovascular, pulmonary, and metabolic). This will optimise safety during exercise testing and participation. For exercise testing requiring the participant to exercise to more vigorous levels, further information may be sought for the risk assessment. Pre-exercise health screening procedures must be valid, cost-effective, time-efficient and appropriate for Firefighters. No set of guidelines for exercise testing and participation can cover all situations. Local policies and risk assessments vary, and specific programme procedures are also properly diverse.

Pre-participation Health Screening

The test administrator should ensure that there are no medical contra-indications to the participant performing the test. Most people do not require a medical check up before taking part in exercise, however the subject should be advised to consult a doctor if there are any doubts about the individuals suitability to take part in moderately vigorous exercise (Sykes, 2005). Appendix A presents a widely used pre-participation screening test for apparently healthy individuals for moderate exercise (ACSM, 2006).

Blood Pressure

In most situations, resting blood pressure would normally be measured prior to undertaking an exercise test. If this is found to be high (e.g. above 160mmHg Systolic and/or 100mmHg Diastolic) then the test would not be conducted and the individual would be advised to consult a doctor for medical consent before proceeding (Sykes, 2005).

Chapter 4

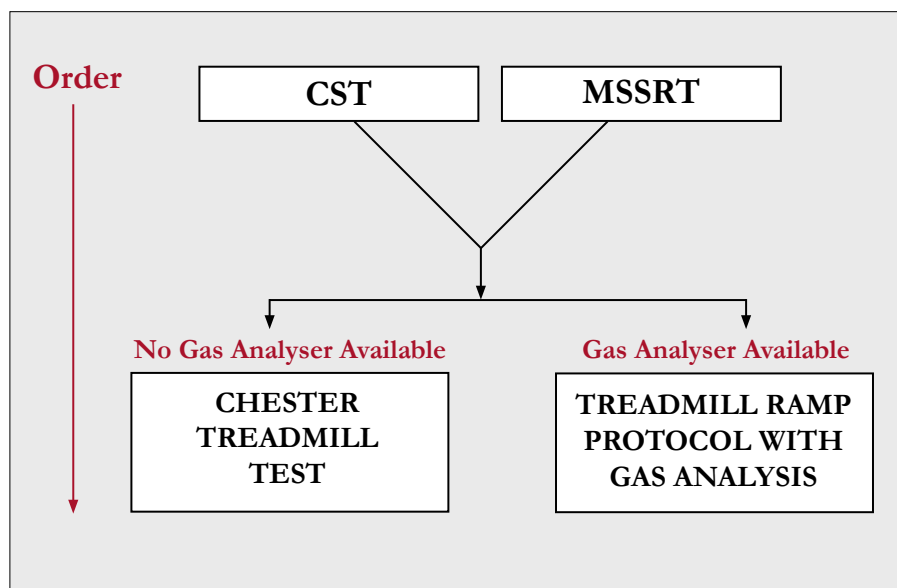
4.1 Exercise Testing

The information regarding a Firefighter's physical fitness is sought in order to ensure that they continue to demonstrate the physical attributes required to perform their role safely and effectively. Fitness advisers / exercise practitioners must be able to select an exercise mode and test protocol that is suitable for the individual(s) being tested. The tests selected must be specific, valid, reproducible and sensitive (see glossary for description).

Delivering a fitness-testing programme within a Fire & Rescue Service is a sizeable task, which is often subject to limited resources. Considering the resource implications with the on-going fitness programme it would be prudent in the first instance to administer a quick and simple test. For the majority, this may mean using tests such as the Chester Step Test (CST) or Multi-Stage Shuttle Run Test (MSSRT), both of which have been shown to be effective at measuring cardio-respiratory fitness.

Where there is doubt as to the accuracy of the results of an aerobic fitness test, or whether a Firefighter has reached the desired level, it may be appropriate to substantiate the results using an alternative method. For example, if there is some doubt as to the accuracy of the initial test (perhaps due to the impact of anxiety on heart rate during CST), then an alternative protocol such as the MSSRT test (which does not rely on heart rate to predict physical fitness) could be used to confirm the result. In circumstances where a satisfactory result cannot be attained by use of either of these two tests, particularly when suitability for operational duties is being assessed, direct measurement by gas analysis should be considered (Figure 1). Any outcome producing unsatisfactory results should be reviewed in conjunction with the opinion of an occupational health physician to rule out any underlying medical conditions. Interpretation of aerobic fitness data should also consider other relevant information - for example, activity level, Body Mass Index (BMI), body fat percentage, current health status (recovering from a cold or other illness).

Figure 1. Suggested order of cardiorespiratory fitness tests.



CST - Chester Step Test; MSSRT - Multi Stage Shuttle Run Test

4.2 Cardiorespiratory Fitness

Cardiorespiratory fitness is the ability to perform dynamic exercise involving large muscle groups at moderate to high intensity for prolonged periods (ACSM, 2006). Maximal oxygen uptake (VO_2max), commonly referred to as ‘aerobic capacity’, is a measure of cardiorespiratory fitness and has been consistently shown to be the best predictor of performance in simulated firefighting tasks (Heyman, 2002; Sykes, 2002).

VO_2max is most commonly reported in $\text{mlsO}_2/\text{kg}/\text{min}$, where the absolute score in litres/min has been corrected for body weight. This enables comparisons to be made between individuals of different weights. Aerobic capacity norms for males and females of different ages are also published in $\text{mlsO}_2/\text{kg}/\text{min}$. Both the Chester Step Test and Multistage Shuttle Run Test estimate aerobic capacity in $\text{mlsO}_2/\text{kg}/\text{min}$.

Interestingly, a number of researchers have suggested that for individuals in occupations involving load-carrying (e.g. firefighting), it is more appropriate for VO_2max to be expressed in litres/min. Scientists at the Occupational Health Institute in Helsinki proposed that the minimum VO_2max for ‘smoke-divers’ should be 3.0 litres/min (Sykes, 1995). Bilzon *et al.*, (2001) stated that results from fitness tests expressed in $\text{mlsO}_2/\text{kg}/\text{min}$ may actually discriminate against heavier individuals and that results should be re-calculated to absolute units (litres/min) when assessing the fitness of those in load-carrying jobs. However, VO_2max expressed in absolute units (litres/min) or in relation to body weight ($\text{mlsO}_2/\text{kg}/\text{min}$) are both important since a Firefighter must be able to carry their own body weight as well as external loads (Sykes, 2002). Since there is a relatively limited evidence-base to support proposals for a fitness standard in absolute units, it is recommended that aerobic capacity be expressed in $\text{mlsO}_2/\text{kg}/\text{min}$.

Cardiorespiratory fitness standard for firefighting

It is widely accepted that firefighting is one of the most physically demanding and hazardous occupations with the potential for exposure to severe physiological and environmental thermal loads (Gledhill & Jamnik, 1992; Duncan *et al.*, 1979). Numerous scientific studies have assessed the energy costs of fire fighting and values ranging from 32 - 57 $\text{mlsO}_2/\text{kg}/\text{min}$ have been published, with values averaging around 35 $\text{mlsO}_2/\text{kg}/\text{min}$. However as it is not generally physiologically possible for individuals to perform maximally for longer than about 90 seconds, and typically, fire fighting tasks last significantly longer than this, an individual with a VO_2 of 35 would not be capable of completing the task. It is therefore logical that a safety margin should be applied to this value. Work output can be sustained for longer durations if output is reduced by 20%. Based on this it is recommended that a 20% safety margin should be applied, to enable fire fighting tasks to be carried out safely and effectively. Hence, an operational Firefighter, undertaking a typical operational task at an energy cost of 35 $\text{mlsO}_2/\text{kg}/\text{min}$, would therefore need a VO_2 (aerobic capacity) $(35 + 20\% =) 42 \text{ mlsO}_2/\text{kg}/\text{min}$, this figure is in line with other studies, where standard for Firefighter fitness is commonly recommended at 40-45 $\text{mlsO}_2/\text{kg}/\text{min}$ (Appendix B). Indeed, a comprehensive literature review on the physiological capabilities of Firefighters was commissioned by the ODPM and published in 2004. Within this document it was suggested that “UK Firefighters have a mean VO_2max of 43 $\text{ml}/\text{kg}/\text{min}$ ” (ODPM, 2004).

Based on the available research the recommended minimum aerobic capacity standard for UK Firefighters is 42 $\text{mlsO}_2/\text{kg}/\text{min}$

Although this is a recommended minimum standard, a report published in 2004 on firefighting emphasised that “the fitter and healthier the workforce the harder and quicker they will be able to work, the more efficient they will be, and the quicker they will recover. This is particularly true when working in demanding thermal environments, especially wearing PPE” (Personal Protective Equipment) (ODPM, 2004).

Assessing maximal oxygen uptake (VO_2max)

VO_2max may be assessed using maximal or sub-maximal protocols. Table 1 illustrates the types of tests commonly used to assess cardio-respiratory fitness.

Table 1. Tests to measure cardio-respiratory fitness

Fitness tests	Sub-maximal Test	Maximal Test
Direct Measurement	Gas analysis test using treadmill performed to pre-determined % of max heart rate.	Gas analysis test using treadmill to exhaustion.
Indirect ‘field test’ Measurement	Chester Step test (CST) Chester Treadmill Test (Prediction)	The Multi-Stage Shuttle Run Test (MSSRT) Chester Treadmill Test (Performance)

The decision to use a maximal or sub-maximal exercise test will depend largely on the reasons for the test, the type of subject to be tested, and the availability of appropriate equipment and personnel (ACSM, 2006).

Maximal exercise testing

Maximal exercise testing, where the subject exercises to the point of exhaustion, is considered more accurate than its sub-maximal methods. This is because maximal testing does not depend on the assumptions upon which sub-maximal tests are based (see below). However, maximal tests have the disadvantage of requiring the participants to exercise to the point of volitional fatigue, which in order to be accurate, requires all-out effort. Due to the significant effort required, more detailed health screening and supervision may be necessary.

Sub-maximal exercise testing

Sub-maximal exercise testing overcomes many of the difficulties associated with maximal exercise testing and although it is not as precise as maximal exercise testing, sub-maximal protocols provide a reasonably accurate reflection of an individual's fitness at a lower cost and reduced risk. It also requires less time and effort on the part of the subject (ACSM, 2006). Most sub-maximal tests involve monitoring heart rate. However, sub-maximal exercise tests assume a steady-state heart rate at each exercise intensity, as well as a linear relationship between heart rate, oxygen uptake and work intensity. Sub-maximal tests also assume that the maximal heart rates for individuals with a given age are similar ($220 - \text{age}$) (Heyman, 2002).

Direct measurement of aerobic capacity by gas analysis

Direct measurement is considered the 'gold standard' in the assessment of cardiorespiratory fitness. Direct measurement requires the subject to wear a mask covering the mouth and nose or use a mouthpiece and noseclip. This is connected, via a low resistance breathing valve to either Douglas bags for gas collection and later analysis or directly to an on-line gas analyser providing breath-by-breath data.

Direct measurement of aerobic capacity using gas analysis predominantly utilise incremental ramp protocols carried out on either a treadmill or static cycle. Protocol selection, including starting load (e.g. Watts / speed / gradient), size and duration of increments and overall duration of the test requires some care and skill on the part of the test supervisor. Protocols used in conjunction with gas analysis should generally aim to bring the subject to maximal effort within an 8-12 minutes time window. The optimum duration of each increment of the protocol ranges from 2-3 minutes. This allows the heart rate to plateau before commencement of the next increment. The load applied at subsequent increments should increase uniformly (e.g. by 3% gradient per stage).

Calibration of the measuring equipment is essential for maintaining accuracy. The equipment is usually calibrated before each test and requires regular servicing. While direct measurement of aerobic capacity is regarded as the most accurate, careful attention should be taken when fitting the face mask as any leakage between the face mask and face can lead to inaccurate results. Another factor for consideration by the test supervisor is the criteria for termination of the test. When using a maximal protocol, test termination will usually be determined by the subject and occur at a point when they feel unable to continue. In some cases subjects may not have sufficient psychological or motivational strength to push themselves to a true maximum effort. This could result in the test being terminated before $\text{VO}_{2\text{max}}$ has been attained thus understating the true value. Considerable encouragement by the test supervisor may be required to urge the subject to maximal effort.

Difficulties in determining the attainment of maximal effort has led to the use of 'secondary criteria' as additional determinants of maximal effort; these are typically: an increase in heart rate to reach age-related theoretical maximum or a respiratory exchange ratio (RER) of ≥ 1.15 . However, the use of age-adjusted estimates of maximal heart rates have been proposed as problematic due to a standard deviation of ± 11 beats/min and therefore should not be used in isolation (ACSM, 2006).

Indirect measurement of aerobic capacity

Indirect methods of assessing aerobic capacity have several advantages over maximal testing: they require much less sophisticated equipment and technical support, making them more cost effective, can be performed 'in the field' and are often suitable for mass testing (e.g. Multi-Stage Shuttle Run Test). However, indirect assessments of aerobic capacity are predictive and therefore are subject to error known as the standard error of estimate (SEE). Errors of estimate are usually expressed in the measurement units of the predicted variable (e.g. $\text{mlsO}_2/\text{kg}/\text{min}$). For example: a predictive result of $55 \text{ mlsO}_2/\text{kg}/\text{min}$ from an aerobic capacity test which has a SEE of $\pm 10 \text{ mlsO}_2/\text{kg}/\text{min}$ would mean that the actual VO_2 max could be between 45 and 65 $\text{mlsO}_2/\text{kg}/\text{min}$. The larger the SEE the less reliable the result obtained from a particular test. Tests with large SEE have low validity and may not be appropriate, where a specific standard has been set. For example, where a role related standard is required in order for safe and effective firefighting.

4.2.1 Exercise Mode

There are a variety of exercise modes, which are commonly utilised to assess cardiorespiratory fitness. The most widely used are the cycle ergometer, treadmill and step testing.

Cycle ergometer

Cycle ergometers are excellent test modalities for sub-maximal and maximal exercise testing. They are relatively inexpensive, easily transportable, and require minimal skill on the part of the participant (ACSM, 2006). They also provide a non-weight bearing method of exercise and allow work rates to be easily adjusted in small increments. The cycle ergometer must be calibrated and the subject must maintain the proper pedal rate because most tests require that heart rate be measured at specific work rates (ACSM, 2006). However, scientific research suggest that test performed by this mode may elicit lower VO_2 max values due to fatigue occurring in the legs before maximal oxygen uptake is achieved (McArdle, Katch & Katch, 2007). Additionally, cycling modes are weight supported and do not replicate firefighting in any way. Because of this, cycle protocols have not been included in this document.

Treadmill

The motor-driven treadmill can be used in both sub-maximal and maximal protocols. Walking or running on a treadmill does not require high levels of skill on the part of the participant and this exercise mode is highly applicable to firefighting tasks. However, treadmills are usually expensive and are not easily transportable.

Stepping

Step testing is an excellent method for predicting cardiorespiratory fitness. A step test requires minimal equipment, is easily standardised, highly transportable and requires little skill on the part of the participant (ACSM, 2006).

4.2.2 Exercise Tests

The Chester Step Test (CST)

Description:

The Chester Step Test (CST) was designed specifically for use in a wide variety of medical and fitness situations. It is a progressive sub-maximal test which requires the subject to step on to and off a step at a rate set by an audio CD, sufficient to elicit a heart rate of 80% of maximum and a moderately vigorous level of physical exertion (Sykes, 2005). Exercise heart rates are plotted on a graph from which maximum aerobic capacity ($\text{VO}_2 \text{ max}$) can be predicted. Alternatively, results can be obtained using CST software, which will enable a more standardised approach. Whilst CST may be conducted using different step heights depending on the occupational or community setting (e.g. rehabilitation), the step height is standardised to 30cm (12") within the Fire and Rescue Service.

Strengths and Weaknesses:

The CST is a test designed to provide a safe and practical means of assessing aerobic fitness under sub-maximal conditions (Sykes, 2005). The test requires no calibration and can be quickly administered in a many different environments. This test is also well suited to both males and females and has no gender or height bias. However, tests that utilise heart rates for the prediction of aerobic capacity generally have a SEE of around 12-15%. Whilst carefully standardising pre-test conditions and test procedures will improve the accuracy and meaningfulness of the results, the exercise heart rate may be affected by anxiety, poor stepping technique, erratic breathing patterns, time of day and certain medication and drugs (which may be unreported) (Sykes, 2005).

Reliability and Validity:

The CST has been reported to be reliable on a test-retest basis (Sykes, 1995). It has also been shown to be reasonably valid for the estimation of aerobic capacity (Sykes & Roberts, 2004) and is well suited to monitoring changes (Sykes & Roberts, 2004).

Multi-Stage Shuttle Run Test (MSSRT) (20-metre)

Description:

The Multi-Stage Shuttle Run Test (MSSRT) was designed for children and adults attending fitness classes, and athletes participating in multiple sprint sports (Leger & Lambert, 1988). The test requires subjects to run between 2 lines spaced 20-m apart at a pace set by the audible signals on a CD (Noonan & Dean, 2000). The starting speed of the test is 8.5 km per hour, and the frequency of the signals is increased 0.5 km per hour each minute. When the subject can no longer maintain the set pace, the last completed level is used to predict VO_2 max from regression equations (Leger & Lambert, 1988; Brewer, Ramsbottom & Williams, 1988).

Strengths and Weaknesses:

The Multi-Stage Shuttle Run Test is a quick and simple test to administer. It requires minimal equipment and more than one individual can be tested at a time. Due to its progressive nature, it requires little warm-up or preparation time, and enables a wide range of fitness levels to be tested (Noonan & Dean, 2000).

Because of the frequent stopping and starting, this test may not be suitable for those with musculo-skeletal impairments, or the elderly. Where subjects are required to reach a specific standard, this test has the potential to be maximal for some, and as such individual health screening and suitable test criteria should be performed before administering the test (Appendix A). Wherever possible, an audio CD should be used to minimise error. Care should also be taken to ensure the track is exactly 20 metres in distance. The recommended aerobic capacity standard of 42 $\text{mlsO}_2/\text{kg}/\text{min}$ requires the participant to achieve Shuttle Run Level 8-6.

Reliability and Validity:

The tests reliability has been reported as being very good amongst adults aged 18-45 years ($r=0.95$)(Leger & Lambert, 1988). Test validity has also been confirmed by demonstrating a high correlation between the Multi-Stage Shuttle Run Test and a VO_2 max test ($r = 0.93$)(Paliczka *et al.*, 1987).

Chester Treadmill Test (CTT)

This test has two modes:

1. CTT Performance
2. CTT Prediction (of aerobic capacity)

CTT Performance

Description:

CTT Performance (Sykes 2007) is a 12-minute graded, treadmill walk test designed to assess whether or not the subject can achieve the minimum recommended standard for aerobic capacity, namely 42mlsO₂/kg/min.

Pre-test:

1. There should be no medical contraindications to performing potentially exhaustive exercise (Appendix A).
2. The subject should wear loose-fitting clothing or shorts/T-shirt and trainers or similar footwear suitable for walking on a treadmill
3. The subject should be very familiar with walking briskly on a treadmill without using handrails for support.
4. An RPE Chart should be clearly visible to the subject.

Test Protocol:

1. Following a gentle loosening and limbering, the subject is then asked to walk on the treadmill at 0% for a 2-minute warm-up, the speed being gradually increased to 6.2km/hr, when the test is commenced.
2. Level 1: 0-2 minutes at 0% gradient. At the end of the level, check that RPE (see chart) is less than 18 and if so, continue to Level 2, increasing the gradient to 3%.
3. Level 2: 2-4 minutes at 3%. At the end of the level, check that RPE is less than 18 and if so, continue to Level 3, increasing the gradient to 6%.
4. Level 3: 4-6 minutes at 6%. At the end of the level, check that RPE is less than 18 and if so, continue to Level 4, increasing the gradient to 9%.
5. Level 4: 6-8 minutes at 9%. At the end of the level, check that RPE is less than 18 and if so, continue to Level 5, increasing the gradient to 12%.
6. Level 5: 8-10 minutes at 12%. At the end of the level, check that RPE is less than 18 and if so, continue to Level 6, increasing the gradient to 15%.
7. Level 2: 10-12 minutes at 15%. At the end of the level, check that RPE is less than 18. End of test.

After 12 minutes, the subject will have reached the required fitness standard of 42mlsO₂/kg/min (Table 2).

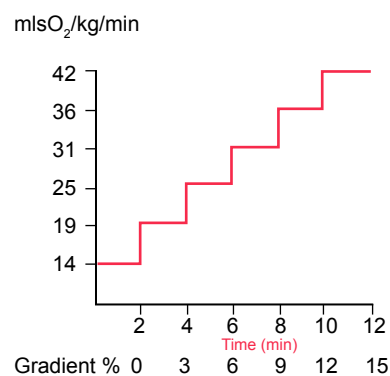
Cautionary note:

For some, this will be a maximum test and for the less fit will be beyond their capabilities. Care should be taken by the tester to ensure that if the subject is unable to keep up with the work rate, reports an RPE of 18 or more and becomes overly distressed, the test should be stopped and the subject should be allowed to cool down and recover.

Table 2. Energy cost (mlsO₂/kg/min) of treadmill walking at 6.2km/hr at different gradients.

Time (mins)	0-2	2-4	4-6	6-8	8-10	10-12
Treadmill Gradient	0%	3%	6%	9%	12%	15%
VO ₂ (mlsO ₂ /kg/min) (oxygen cost)	14	19	25	31	36	42

Figure 2. Chester Treadmill Test Protocol



Strengths and Weaknesses:

This is a highly appropriate test for assessment of Firefighter fitness, using the leg muscles in a familiar exercise to climb increasingly severe gradients.

Note: For those unable to complete all 6 stages, aerobic capacity may be estimated from the time and gradient that the subject was able to complete (e.g. if the subject was able to walk for only 8 minutes before having to stop the test, aerobic capacity may be estimated from Table 2 at 31mlsO₂/kg/min).

Approximate values may also be estimated if a subject stops in mid-Level (e.g. subject reaches an RPE of 18 after 7 minutes and decides to stop, the aerobic capacity will be around 28mlsO₂/kg/min).

Reliability and Validity:

The measured VO_2 at a given work rate is highly reproducible for a given individual; however, the inter-subject variability in measured VO_2 may have a standard error of estimate of around 5% (ACSM, 2006). Therefore, as with other predictive tests, results need cautious interpretation.

Please Note: CTT Performance is specifically designed to assess whether or not an individual has an aerobic capacity of at least 42 $\text{mlsO}_2/\text{kg}/\text{min}$. For some, this can be a tough test – similar in nature to the Multistage Shuttle Run – and may require maximum or near maximum exertion for the less fit. It should be therefore carefully administered.

CTT Prediction

Description:

CTT Prediction (Sykes 2008) is a submaximal test designed to predict aerobic capacity. The treadmill walk protocol is exactly the same as for CTT Performance, however in this test a heart rate monitor is worn and the test is stopped when the subject reaches 80%HRMax and/or an RPE of 14. HRs are then plotted on the CTT Prediction graphical datasheet or inputted into the bespoke software - and aerobic capacity calculated.

Pre-test:

1. There should be no medical contraindications to performing moderately vigorous exercise.
2. The subject should wear loose-fitting clothing or shorts/T-shirt and trainers or similar footwear suitable for walking on a treadmill.
3. The subject should be very familiar with walking briskly on a treadmill without using handrails for support.
4. A Heart Rate monitor should be fitted to the subject; RPE Chart should be clearly visible to the subject.
5. Calculate maximum heart rate ($\text{HRMax} = 200 - \text{age}$) and 80%HRMax and record on the datasheet.

Test Protocol:

1. Following a gentle loosening and limbering, the subject is then asked to walk on the treadmill at 0% for a 2-minute warm-up, the speed being gradually increased to 6.2km/hr, when the test is commenced.
2. Level 1: 0-2 minutes at 0% gradient. At the end of the level, record HR and RPE. If HR is below 80%HRMax and RPE is 14 or less, continue to level 2 by increasing the gradient to 3%.
3. Level 2: 2-4 minutes at 3%. At the end of the level, record HR and RPE. If HR is below 80%HRMax and RPE is 14 or less, continue to level 3, increasing the gradient to 6%.
4. Level 3: 4-6 minutes at 6%. At the end of the level, record HR and RPE. If HR is below 80%HRMax and RPE is 14 or less, continue to level 4, increasing the gradient to 9%.
5. Level 4: 6-8 minutes at 9%. At the end of the level, record HR and RPE. If HR is below 80%HRMax and RPE is 14 or less, continue to level 5, increasing the gradient to 12%.
6. Level 5: 8-10 minutes at 12%. At the end of the level, record HR and RPE. If HR is below 80%HRMax and RPE is 14 or less, continue to level 6, increasing the gradient to 15%.

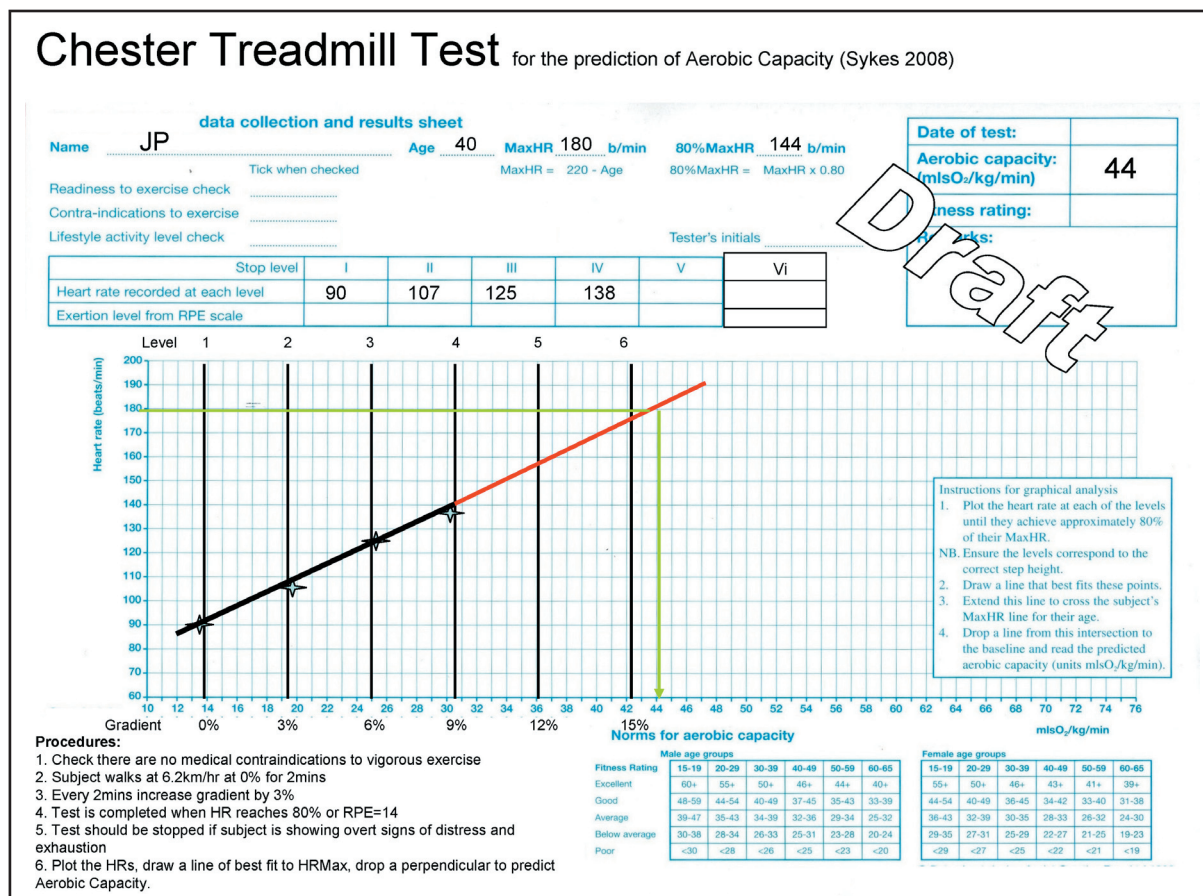
7. Level 6: 10-12 minutes at 15%. At the end of the level, check that RPE is 14 or less and HR is less than 80%HRMax. End of test.

Please Note: The test should be stopped if/when the subject reaches 80%HRMax or reports an RPE of more than 14 – or appears unduly distressed.

Prediction of Aerobic Capacity

Record HRs on the CTT Prediction graphical data sheets (figure 3 below) and/or input data into bespoke software to predict aerobic capacity and ascertain fitness level.

Figure 3. Chester Treadmill Test - Prediction of aerobic capacity



Resource Availability:

CTT Prediction graphical datasheets and software calculator are commercially available.

Reliability and Validity:

The measured VO₂ at a given work rate is highly reproducible for a given individual; however, the inter-subject variability in measured VO₂ may have a standard error of estimate of around 5% (ACSM, 2006). Therefore, as with other predictive tests, results need cautious interpretation.

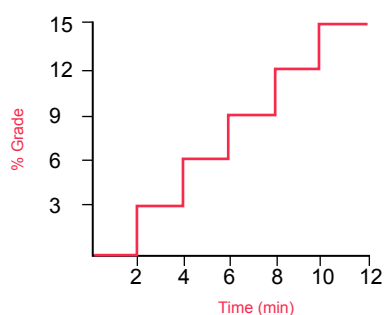
Treadmill Ramp Protocol

Description:

Ramp protocols are designed for use in conjunction with a gas analyser and should only be used by qualified fitness professionals with suitable technical skills and experience. Ramp protocols have increased in popularity in recent years because of the need for more gradual, individualised approaches for exercise testing. Ramp protocols are more tailored to the individual and the purpose of the test, rather than applying the same protocol for every subject, thereby improving the ability to predict oxygen uptake and VO_2max . Increases in external work (speed and grade on a treadmill) occur in a constant and continuous fashion and the workload (ramp rate) can be personalised throughout a wide range of subject capabilities (Myers & Bellin, 2000). Ideally, increments in work rate should be chosen so that the test time ranges between 8-12 minutes.

The subject should be familiar with walking briskly on a treadmill and there should be no contraindications to performing potentially exhaustive work (Appendix A). Following a gentle loosening and limbering warm-up, subjects are then asked to select their fastest walking speed on the treadmill. This is commonly between 5 and 7 km/hour. The test will be commenced at this speed at 0% gradient and every 2 minutes the gradient is increased by 3% until the subject can no longer safely maintain this pace (Figure 3). As with previously described tests, for some, this will be a maximum test and care should be taken by the tester to ensure that if the subject is unable to keep up with the workrate and becomes overly distressed, the test should be stopped and the subject should be allowed to cool down.

Figure 3. Treadmill ramp protocol



Strengths and Weaknesses:

Advantages of the ramp approach include individualising the test protocol to the participant. However, it is important that the treadmill to be used is accurately calibrated and capable of precise settings.

Reliability and Validity:

Due to the individualised nature of the test protocol, VO_2max values are highly valid and reproducible. However, considerable operator expertise is required to ensure that the test protocol is appropriate, the metabolic analysis equipment is carefully calibrated and the resultant data is accurately interpreted.

4.3 Muscular Strength

Physical strength is well known to be an important component for effective firefighting (ODPM, 2004) and is capable of being developed with an effective physical training programme (Appendix E, F & G). Whilst the majority of this report focuses on the aerobic component of physical fitness, which maybe considered as the most important component maintaining muscular strength is also essential. It should be remembered that a lack of physical strength cannot be compensated for by any of the other fitness elements (e.g. cardiorespiratory fitness or muscular endurance). It is therefore important to have a balance of the various components of physical fitness. Muscular strength is directly related to the cross sectional area of the muscle mass regardless of gender (McArdle, Katch & Katch, 2007). As such those with greater muscle mass will be able to generate more force. However this force output capacity varies depending on the arrangement of the bony levers and muscle architecture (McArdle, Katch & Katch, 2007).

Strength testing may not necessarily form a mandatory part of the on-going fitness assessment. However, there may be times during an operational incident or a fire training exercise when a strength issue may be identified. Following this it may be appropriate to administer a test to check for competence. As there are few standardised strength tests that directly relate to firefighting, it may be appropriate to perform a number of firefighting tasks e.g. ladder lift, lightweight portable pump carry, ladder extension etc. A potential option may be to use the Ladder Lift Simulator (developed for the National Firefighter Selection (NFS) tests) to test the upper body strength required to raise a ladder onto the fire appliance (see below). This may identify a training need so that a suitable exercise programme can be undertaken to improve the individual's physical strength (Appendix F).

Maximum strength can be defined as the maximum force a muscle or group of muscles can generate. A recommended Protocol for strength testing is as follows:

- Appropriate warm up and the performance of several practice contractions should precede testing.
- Prolonged stretching performed prior to testing can reduce maximum force production, so stretching during a warm-up should be minimal, and repeated exactly in subsequent testing sessions
- Repeated testing should be conducted at the same time of day, with the same environmental conditions (e.g. room temperature) and after the same pre-testing routine is performed, wherever possible.
- Participants should be highly motivated for every attempt
- Tests should be selected that are closely related to the task being trained for (Blazevich & Cannavan, 2006).

4.3.1 Exercise Tests

Ladder Lift Test

Description:

The ladder lift simulator was designed for the NFS to identify if candidates are able to demonstrate the physical potential to become a Firefighter. The weight required to be lifted for an operational Firefighter would be different to that stated for the NFS recruitment test and should simulate lifting $\frac{1}{4}$ of a 13.5m ladder on to the back of the fire appliance, which is equivalent to approximately 30kg (Figure 4). Additionally, an operational Firefighter may be required to perform this task repeatedly and as such a test involving a single lift may not be adequate. For further information on this test, refer to the NFS guidance document.

Figure 4. NFS ladder lift simulator.



Strengths and Weaknesses:

The ladder lift test simulates closely the action required to lift the ladder to the designated height and therefore requires the participant to use the same muscles in a similar action. However this test only allows movement in a fixed plane and therefore does not reflect the true nature of a lift on the fire ground where greater activation of the body's stabilising muscles may be required.

Reliability and Validity:

No reliability or validity data are available for this test. However the test has face validity due to the functional similarity to firefighting tasks.

Chapter 5

5.1 Maintaining Physical Fitness for Firefighting

In order to improve any of the components of physical fitness, engaging in regular exercise is fundamental. All components of physical fitness are developed by the progressive overload principle, i.e. “an exercise overload specific to the activity must be applied to enhance physiological improvement and bring about a training response” (McArdle, Katch & Katch, 2007). In order to maintain the training effect, exercise must also be continued on a regular basis (Coyle *et al*, 1984). If the training stimulus is not maintained, a detraining effect will occur. For example, a significant reduction in cardiorespiratory fitness occurs after two weeks of detraining (Coyle *et al*, 1984). For guidance on improving and or maintaining physical fitness you should refer to Appendix E (Preparatory Fitness Programme) and Appendix F (Firefighter Fitness Programme).

Chapter 6

6.1 Recommendations

1. The recommended National standard of aerobic fitness is 42 mlsO₂/kg/min and applicable to all Firefighters irrespective of age, gender or duty system.
2. Due to the risks inherent in the job a Firefighter should be withdrawn from operational duties where an aerobic capacity is below 35 mlsO₂/kg/min and remedial steps taken.
3. Routine 6-monthly fitness checks should be compulsory for all operational personnel (Wholetime and Retained), and offered on a voluntary basis to all other staff.
4. Fire & Rescue Services should have a suitable health & fitness policy that identifies how fitness issues are to be managed (see Appendix C).
5. Fire & Rescue Services employee contracts should include a statement which states “The employee has a responsibility for ensuring that they maintain a level of physical fitness necessary to carry out their operational duties”.
6. Fire & Rescue Service employees should have access to expert advice on Firefighter fitness, health and fitness, weight management and health promotion issues.
7. Fire & Rescue Services should allow regular time for physical training so that Firefighters maintain fitness levels appropriate to their role.
8. Fire & Rescue Services should provide suitable commercial grade fitness equipment to allow Firefighters to maintain their fitness levels.
9. Where Fire & Rescue Services are introducing or making significant changes to a health & fitness policy, a suitable amnesty period (e.g. 12 months) may be appropriate to allow Firefighters to improve their fitness levels to the required level.
10. Fire & Rescue Services, either individually or regionally, should acquire the means to measure aerobic fitness by gas analysis.
11. Further practical research is necessary to further quantify the energy requirements of firefighting.
12. Further work needs to be undertaken to identify role specific fitness levels.

Glossary

Cardiorespiratory Fitness	The ability to perform dynamic exercise involving large muscle groups at moderate to high intensity for prolonged periods (ACSM, 2006).
Reproducibility	If data is to be considered meaningful, it must be reproducible. Whilst the variability in measures can be attributed to technical and biological sources, the precision and accuracy of the instruments, coupled with the skill of the administrator / operator are critical. As a result, an indication of error in tests is required if meaningful information is to be provided.
Reliability	The ability of a test to yield consistent and stable scores across trials and over time.
Respiratory Exchange Ratio (RER)	Ratio of expired carbon dioxide (CO_2) to inspired oxygen (O_2).
Sensitivity	Sensitivity is the extent to which physiological measures reflect improvements in performance. Clearly, reproducibility is implicated but sensitivity is probably at the heart of the matter.
Specificity	Assessments should mimic the form of exercise under scrutiny.
Standard error of estimate (SEE)	Measure of error for prediction equations. SEE quantifies the average deviation of individual data points around the line of best fit
Strength	The maximum force a muscle or group of muscles can generate.
Validity	Validity is the extent to which a test measures what it purports to measure.
VO_2 max	The maximum rate at which the body can take up and utilise oxygen.

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Appendices

PAR – Q & YOU

(A questionnaire for people aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: Check YES or NO.

YES	NO	
<input type="checkbox"/>	<input type="checkbox"/>	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
<input type="checkbox"/>	<input type="checkbox"/>	2. Do you feel pain in your chest when you do physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	3. In the past month, have you had chest pain when you were not doing physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	4. Do you lose balance because of dizziness or do you ever lose consciousness?
<input type="checkbox"/>	<input type="checkbox"/>	5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	6. Is your doctor currently prescribing drugs (for example water pills) for your blood pressure or heart condition?
<input type="checkbox"/>	<input type="checkbox"/>	7. Do you know of any other reason why you should not do any physical activity?

**If you
answered**

YES to one or more questions

Talk with your doctor by phone or in person before you start becoming much more physically active or before you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want – as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programmes are safe and helpful to you.

If you answered no honestly to all PAR-Q questions, you can be reasonably sure that you can:

- Start becoming more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- Take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

DELAY BECOMING MUCH MORE ACTIVE:

- If you are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better; or
- If you are or may be pregnant – talk to your doctor before you start becoming more active.

Please note: If your health changes so that you then answered yes to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

Name _____ Date _____

Signature _____ Witness _____

(Reprinted with permission from the Canadian Society of Exercise Physiology, Inc., 1994)

Reference	Country	Study Description	Subjects (n); sex	Variables measured	Result	Comments
Ben Ezra <i>et al.</i> 1988	USA	Assessment of aerobic fitness of serving operational firefighters	38	VO ₂ max	43.1 mlsO ₂ /kg/min	Recommendations were made to include task-specific modes of training and testing methods that include stair climbing.
Bilzon <i>et al.</i> 2001	UK	Quantification of the metabolic demand of fire fighting procedures in the Royal Navy with the purpose of identifying a minimum level of CV fitness during 4 simulated shipboard fire fighting tasks.	49 (34 males; 15 females)	HR; VO ₂ max	Most demanding task elicited ~ 43 mlsO ₂ /kg/min	Most demanding task was 30kg drum carry test. This study recommended a minimum VO ₂ max of 41 mlsO ₂ /kg/min.
Davis <i>et al.</i> , 1982	USA	Assessment of aerobic fitness of serving operational firefighters	100 males	VO ₂ max	39.6 mlsO ₂ /kg/min	Assessment of aerobic capacity
Dreger <i>et al.</i> 2006	Canada	Examining the effects of fire fighting PPE and SCBA on exercise performance	12 male	VO ₂ max	Significant reduction in VO ₂ max of 18%	This paper highlights the negative impact of PPE and SCBA on fire fighter performance. The authors go on to state that to work at greater than 80% of VO ₂ max may compromise the reserve for safe and effective work performance.
Ellam <i>et al.</i> , 1994	UK	Aerobic fitness of serving operational firefighters	40 males	VO ₂ max	46.3 mlsO ₂ /kg/min	Study with London FCDA
Gledhill & Jamnik, 1992	Canada	Characterisation of the physical demands of firefighting.	53 firefighters	VO ₂ max	44 mlsO ₂ /kg/min	Recommendations that all active fire fighters maintain a minimum VO2 max standard of 45 mlsO ₂ /kg/min
Holmer & Gavhed, 2007.	Sweden	Measured metabolic and respiratory responses during simulated work tasks.	15 male	Mean VO ₂ max VE; HR	Mean VO ₂ = 33.9 mlsO ₂ /kg/min	Mean VO ₂ = 2.75 ± 0.29 l/min ⁻¹ (33.9 mlsO ₂ /kg/min). Most demanding task elicited VO ₂ 3.55 ± 0.27 (43.8 mlsO ₂ /kg/min)

Reference	Country	Study Description	Subjects (n); sex	Variables measured	Result	Comments
O'Connell <i>et al.</i> 1986	USA	Assessment of aerobic fitness of serving operational firefighters	17 males	VO ₂ max	48.4 mlsO ₂ /kg/min	Firefighters should have a minimum standard of 39 mlsO ₂ /kg/min all though this would not allow for any safety margin.
Scott <i>et al</i> (1988)	UK	Aerobic fitness of serving firefighters	278 males	VO ₂ max	Mean VO ₂ = 43.7 mlsO ₂ /kg/min	Study with subjects from a number of UK Fire Brigades.
Sharkey <i>et al</i> , 1981	USA	Aerobic fitness of US forest firefighters	97 males	VO ₂ max	Mean VO ₂ = 54.4 mlsO ₂ /kg/min	US forest firefighters.
Sothman <i>et al.</i> 1990.	USA	Validation of a minimum level of aerobic fitness required for strenuous fire suppression tasks wearing SCBA		VO ₂ max. Metabolic demands	Mean VO ₂ = 30.5 mlsO ₂ /kg/min	Minimum standard of 33.5 mlsO ₂ /kg/min was required for the firefighting task. However this did not allow for sufficient emergency reserve. Therefore 41 mlsO ₂ /kg/min was recommended.
Von Heimburg <i>et al.</i> 2006	Norway	Examine the physiological responses of fire fighters during a simulated rescue of hospital patients.	14 male	VO ₂ HR	Peak VO ₂ = 3.7 ± 0.5 l.min ⁻¹ .	Large and heavy fire fighters carried out tasks faster than smaller fire fighters. Effectiveness was related to VO ₂ in l.min ⁻¹ and a minimum VO ₂ of 4.0 l.min ⁻¹ was recommended. The relative value for this group is 48 ml.kg.min ⁻¹ .

VO₂ – oxygen consumption; VE – minute ventilation; HR – heart rate; SCBA – self-contained breathing apparatus; PPE – personal protective equipment.

APPENDIX C

Model Fitness Policy for Fire & Rescue Services

Background/Introduction

The importance of promoting a healthy lifestyle for all employees is well recognised. Low levels of physical activity and fitness are known risk factors for coronary heart disease, diabetes, stroke, and some forms of cancer. These risks may be exacerbated by obesity and poor lifestyle. Furthermore, it is also well established that the role of firefighting imposes significant physiological strain on the body. Consequently, maintaining an appropriate level of physical fitness is paramount in ensuring that firefighting personnel are able to perform the role safely and effectively, and to help minimise the risk of personal injury and illness.

This document sets out the processes, standards, and supporting information necessary for an effective fitness assessment policy.

Legislative/Supporting Information

Health & Safety at Work Act (1974)

Human Rights Act (1998)

Race Relations (Amendment) Act 2000

Sex Discrimination Act 1975

Disability Discrimination Act 2005

Data Protection Act 2000

Fire Service Circular 8/1991

Fit for Duty Report (2000)

Buildings Disaster Assessment Group (2004)

Operational Physiological Capabilities of Fire Fighters: Literature Review & Recommendations – ODPM 2004

www.firefitsteeringgroup.co.uk

Objectives

The key objectives of the policy are to:

- Provide a means of measuring personal fitness levels
- Ensure individual fitness standards meet the requirements of the role
- Improve/maintain individual fitness levels
- Promote healthy lifestyles
- Provide effective remedial support and advice

Scope of the Policy/Target Population

All Wholetime and Retained uniformed personnel (except control) are required to undertake routine fitness assessments as set out in the policy. Fitness assessments may be offered to non-uniformed and control personnel subject to approval by respective line managers.

Frequency of Assessment

Fitness assessments should be undertaken on a six-monthly basis.

Assessment Administration/Quality Assurance

Prior to the assessment personnel should refrain from participating in vigorous activity. They should also refrain from smoking or drinking caffeinated drinks for at least one hour prior to assessment. Individuals may be required to complete a physical activity readiness questionnaire (PAR-Q) prior to commencement of the assessment, depending on the type of test being used and the past history of the individual being tested. Where aerobic fitness protocols using heart rate are employed it is important to identify prescribed medication which affects heart rate i.e. beta blockers.

All fitness assessments will be supervised by suitably qualified, experienced occupational health specialists or fitness advisers. The assessment should take place at a suitable location allowing for privacy and individual dignity. All data collected will be stored subject to the data protection act 2000. The results of the assessment will be confidential between the assessor and the individual except where further intervention is required e.g. further medical checks, supporting fitness assessment, where individual does not meet required minimum standard for operational duties.

Following the assessment the supervisor will provide a report and explanation of the results attained along with any additional advice necessary. Anonymous statistical data may be collected for analysis of performance indicators.

Assessment Methods/Procedures

Providing no medical issues have been highlighted following completion of the PAR-Q, the following health/fitness assessments will be carried out:

- Blood pressure
- Aerobic fitness

Blood pressure

Blood pressure is a measurement of the force exerted by the blood circulating in the arteries. Two readings are taken: one indicates force while the heart's ventricles are contracting (systolic pressure) and the other reading records the blood pressure during ventricle relaxation (diastolic pressure). Blood pressure varies amongst individuals and normally increases with age. If a person's blood pressure is higher than normal on at least three separate occasions, a doctor may diagnose hypertension. Blood pressure is measured by a Sphygmomanometer and stethoscope and is normally expressed as two figures (e.g. 120/80). This is because the blood pressure varies throughout each heart beat cycle, reaching its peak when the main chambers of the heart contract and at its lowest as they relax. The usual figure for arterial blood pressure is 120/80 but as people get older the arteries lose their elasticity and the blood pressure therefore naturally rises. Diastolic pressure is the greater indicator of future problems as this represents the persistent pressure rather than the intermittent pressure. In general a diastolic pressure of over 95 is considered as hypertension though more concern would be attributed to this level in a 25 year old than a 60 year old.

Raised blood pressure can be an indication of an underlying condition and therefore further tests are normally carried out if an abnormally high reading is found.

Category	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Optimal blood pressure	<120	<80
Normal blood pressure	<130	<85
High-normal blood pressure	130-139	85-95
Grade 1 hypertension (mild)	140-159	90-99
Grade 2 hypertension (moderate)	160/179	100-109
Grade 3 hypertension (severe)	≥180	≥110

Cardiorespiratory Fitness

Cardiorespiratory Fitness can be defined as a measure of the efficiency of the heart, lungs, blood vessels and muscles to take up, transport and use oxygen. It is measured in millilitres of oxygen per kilogram of body weight per minute (mlsO₂/kg/min).

A range of tests exist to either predict or directly measure cardiorespiratory fitness. All have varying strengths and weaknesses. Occupational health/Fitness advisers should select the most appropriate test for the situation (see FireFit Guidance Document – Fitness For Fire and Rescue. Standards, Protocols and Policy, 2009).

Exercise Tests

The Chester Step Test

Individuals will be fitted with a heart rate monitor and asked to step up and down on a 30cm step in time with an audio signal on a CD. Every two minutes the heart rate will be recorded and the stepping rate will increase. The test will last up to ten minutes or until the heart rate reaches 80% of its maximum as determined by the formula 220 -age. The data enables a prediction of aerobic capacity to be calculated.

Multi Stage Shuttle Run Test

This test requires a subject to run between two lines 20m apart in time to an audio signal on a CD. Approximately every minute the time between each audio signal reduces requiring the subject to speed up to keep in time. The subject should keep running until they can no longer reach the lines at the time of the audio 'bleep'. At this point they should withdraw from the test and the level/shuttle number is recorded. Aerobic capacity can then be predicted by use of a simple 'look up' table.

The Chester Treadmill Test (CTT)

Subjects are asked to walk on the treadmill at 0% gradient, the speed gradually being increased to 6.2km/hr, when the test is commenced. This is potentially a 12-minute test, walking at the constant pace of 6.2km/hr. Commencing at 0%, the gradient is increased by 3% every 2 minutes. After 12 minutes, the subject will have reached the required fitness standard of 42mlsO₂/kg/min (see table below).

Energy cost (mlsO₂/kg/min) of treadmill walking at 6.2km/hr at different gradients.

Time (mins)	0-2	2-4	4-6	6-8	8-10	10-12
Treadmill Gradient	0%	3%	6%	9%	12%	15%
VO ₂ (mlsO ₂ /kg/min) (oxygen cost)	14	19	25	31	36	42

Gas Analysis

Gas analysis is the 'gold standard' method of measuring aerobic capacity, which is achieved by measuring the volume of oxygen in the expired breath during maximal physical exercise using large muscle groups. The subject will be fitted with a face mask covering the mouth and nose or a mouthpiece with nose occluded. This is connected, via a low resistance breathing valve to an on-line analyser which provides breath by breath data. Exercise protocols used in conjunction with this method aim to bring the subject to maximal effort within an 8-12 minute time window. This is achieved by an incremental 'ramp' method whereby additional resistance is applied every 2-3 minutes until the subject reaches maximal effort. The oxygen consumption at this point is the individuals VO₂max or aerobic fitness level.

Treadmill ramp protocol for use with gas analysis

The subject is required to walk on the treadmill at a self selected fast walking pace. This is commonly between 5 and 7 km/hour (and will be dependant on leg length and fitness standard and will be determined by the person taking the test). Every 2 minutes the gradient will be increased by 3% until a point is reached when the subject can no longer maintain the required output up to a maximum of 12 minutes.

Muscular Strength

Strength testing may not necessarily form a mandatory part of the on-going fitness assessment. However, there may be times during an operational incident or a fire training exercise when a strength issue may be identified. Following this it may be appropriate to administer a test to check for competence. As there are few standardised strength tests that directly relate to firefighting, it may be appropriate to perform a number of firefighting tasks e.g. ladder lift, lightweight portable pump carry, ladder extension etc. A potential option may be to use the Ladder Lift Simulator (developed for the National Firefighter Selection (NFS) tests) to test the upper body strength required to raise a ladder onto the fire appliance. This may identify a training need so that a suitable exercise programme can be undertaken to improve the individual's physical strength.

Occupational health/Fitness advisers should refer to the recommended protocol for strength testing as outlined in the FireFit Guidance Document – Fitness for Fire and Rescue. Standards, Protocols and Policy 2009.

Fitness Standards

Blood Pressure

Individuals demonstrating blood pressure readings of $>160/100$ should be referred to the Occupational Health Physician. Individuals with blood pressure readings >180 systolic and >120 diastolic should be removed from operational duties until the hypertension is controlled.

Cardiorespiratory Fitness (VO_2)

The recommended National standard of cardiorespiratory fitness for operational Firefighters is $42 \text{ mlsO}_2/\text{kg}/\text{min}$ and is applicable irrespective of age, gender or duty system. Due to the risks inherent in the role fire fighting personnel should be withdrawn from operational duties where aerobic capacity is below $35 \text{ mlsO}_2/\text{kg}/\text{min}$.

Strength

If using the Ladder Lift Simulator, operational Firefighters should simulate the lifting of $\frac{1}{4}$ of a 13.5m ladder on to the back of the fire appliance, which is equivalent to approximately 30kg. Additionally, an operational Firefighter may be required to perform this task repeatedly and as such a test involving a single lift may not be adequate. For further information on this test, refer to the NFS guidance document.

Failure to reach required aerobic fitness standard

All operational personnel are required to:

- Maintain a state of physical fitness for operational duties that includes an appropriate body weight, aerobic fitness, strength and muscular endurance levels
- Take appropriate steps to prevent becoming overweight/obese
- Attend fitness assessments or review consultations outlined within the policy

Individuals who are found to have a VO_2 level below $35 \text{ mlsO}_2/\text{kg}/\text{min}$ will be required to undertake a further assessment to validate the result of the original assessment, and where possible this validation should be undertaken using gas analysis. Occupational health/Fitness advisors should refer to the protocol as outlined in the 'Suggested order of cardiorespiratory fitness tests' (Fitness for Fire and Rescue. Standards, Protocols and Policy, 2009). This should be completed within a short time-scale (2-4 weeks). If the result is confirmed the individual will be withdrawn from operational duties and a remedial fitness programme initiated.

If aerobic fitness is found to be within the range $35 - 41 \text{ mlsO}_2/\text{kg}/\text{min}$ and the individual will remain on normal operational duties but be placed on review until they achieve a VO_2 of $42 \text{ mlsO}_2/\text{kg}/\text{min}$ or above. Throughout this period they should be offered personalised remedial advice and be required to undergo further assessment at regular intervals.

It is recognised that there may be other health factors such as body weight / composition that may compromise the operational effectiveness of a Firefighter. Risk assessment on an individual basis is advised.

RPE SCALE



